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RESEARCH RESULTS OF THE COMBINED MACHINE THAT FERTILIZES THE SOIL ON THE SLOPES

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Abstract: One of the important agrotechnical measures that ensure abundant and high-quality harvest is the equal distribution of mineral fertilizers in the field. Equal distribution of nutrients (nitrogen, phosphorus, potassium) in equal quantities, equality of nutrient points in the soil layer is ensured. An environment of continuous nutrition of the seed is created. Even distribution of mineral fertilizers in the soil layer in grain cultivation, as well as plant resistance during wintering, has a positive effect on plant height and quality grain maturity. In our research work, by evenly distributing mineral fertilizers in the soil layer, more than 6 centners of yield per hectare was obtained. A combined machine was developed in our laboratory, experimental field and laboratory tests were conducted. According to the main results of the research, 3 types of mineral fertilizers were taken. Urea, double superphosphate, potassium fertilizers were determined in the distribution percentage and amount of fertilizers on slopes up to 15 degrees. Depending on the slopes, the amount of distribution of mineral fertilizers per 1 m^2 and the amount of fertilizers per plant were determined. Based on the obtained results, graphs and tables were drawn up and analyzed.

Key words: *Combined plough; slopes; mineral fertilizers; equal distribution; degree*

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INTRODUCTION

The Republic of Azerbaijan is a typical mountainous country, high mountains have created its own relief, which creates conditions for the formation of a well-formed soil-vegetation cover. Here, the diversity and complexity of the relief conditions, the unique characteristics of the climate, the plowing and cultivation works in the direction of the width of the slope in highly inclined areas and the application of soil protection measures have led to the development and wide spread of mountain farming.The territory of the republic consisted of 8.6 million hectares, 60% of which is covered by mountainous and foothill regions.

As a result of non-application of the rotation system in mountain farming, insufficient application of mineral fertilizers, especially organic fertilizers, and failure to carry out agrotechnical measures, the upper fertile layer of the soil is washed away and poured into streams and rivers, as a result of which a large amount of humus, nitrogen and other nutrients are lost.In such soils, the energy reserve of the upper humus layer is also sharply reduced, [3].

In order to prevent water erosion in the mountain regions of Azerbaijan, they currently plow the soil across the slope or in the horizontal direction of the field (along the contour).In most cases, the sowing of agricultural crops is carried out in the direction of the width of the slope. However, in narrow areas where it is not possible to move plows and seeding units in the direction of the width of the slope, all operations are carried out in the direction of the length of the slope, as a result of which the farmlands are exposed to the destructive effect of water erosion and become completely unsuitable for agriculture.Observations show that on slopes with a slope of more than 6°, the destructive effect of water is manifested even when plowing and sowing work is carried out in the direction of the width of the field.

The experience of many years shows that in the mountain and foothill regions of the republic, due to the application of the rotation system of grass fields and mineral fertilizers, autumn crops (wheat, barley, etc.) produce more than spring crops. In general, up to 60% of mountain farmland is devoted to winter grain.Therefore, it is of particular importance to develop and apply the progressive technology of soil cultivation and appropriate mechanization tools to prevent water erosion in the winter crops located on the mountain slopes, [7].

For the main application of solid mineral fertilizers in our country, almost all farmers and more than 60% of European countries have disc centrifugal fertilizer spreaders. Machines of this type have proved to be reliable, high productivity, structurally simple, low energy consumption and maneuverability during their operation for many years. The technological process of distributing fertilizers through these machines is very simple.Under the influence of centrifugal force, fertilizers are accelerated along the blades and spread around the machine on the surface of the soil, flying in a fan-shaped flow, [13].

In the last two decades, the productivity of machines for supplying mineral fertilizers has increased by 2-3 times, spreading width by 1.5-2.5 times, load-carrying capacity by 10 times, and special metal consumption has decreased by 10-20%.

The working width of the spreader always exceeds the design dimensions of machines with centrifugal working bodies, which is one of their main advantages.

In this case, the dispersion equation usually works with the previously unknown overlap of adjacent transitions, [4].The impossibility of strictly fixing the optimal working width is one of the main disadvantages of centrifugal working bodies of fertilizer machines.The optimal working width determined experimentally for a certain type of fertilizer with changes in working conditions limits it to be so.In addition, the actual working width of the machine does not always correspond to the optimal spreading, which causes speed variations and uneven application.It follows from this that the agrotechnical indicators of the centrifugal working bodies of the machines depend on each other and do not remain stable during operation due to the influence of many factors, [5;12].

Machines with a centrifugal working body are not able to apply powder and granular fertilizers over a large working width.But the main drawback of these machines is the uneven distribution of fertilizers, especially when working on slopes. In farm conditions, it reaches 80% and often exceeds the allowed agricultural requirements by 2 - 8 times [11].

MATERIAL AND METODS

The combined plough was developed in our laboratory to ensure an equal amount of mineral fertilizer under the plow. A new smooth spreading working part has been developed to ensure even spreading of fertilizers.It is installed on the rear part of the smooth distributing bucket [6;8]. The main factor affecting the productivity and technological process of the distributed bucket is the fertilizer rate.The fertilizer rate is divided into 19 levels. Norms are determined based on field monitoring and analysis. NDVI taken by drone or GIS system can be determined based on maps. Our main goal is to determine the fertilizer norms and the amount of mineral fertilizer applied to each tissue in order to achieve an even distribution of mineral fertilizers on the slopes. Our main goals are to provide the root system of grain with nutrients in the soil, [9].

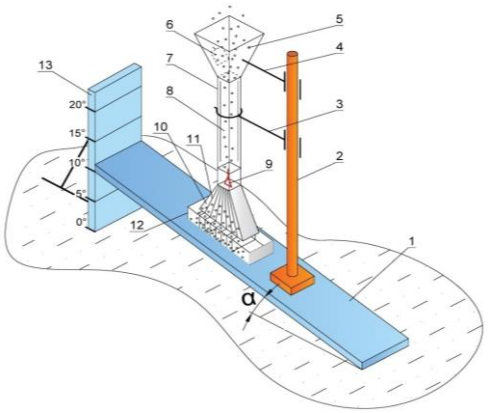


Figure 1. Device for determining the dispersion equation of a smooth scatterer
1-main support; 2- tripod; 3; 4–holder; 5–fertilizer box; 6–valve regulating the fertilizer rate; 7–fertilizer tube cover; –fertilizer pipe; 9–pendulum cone; 10-fertilizer distributor; 11 – partition; 12 - partitioned container for pouring fertilizer; 13 – regulating the slope along the vertical support

Experimental studies of the newly created smooth scattering part were carried out in the laboratory at 4 main degrees of inclination by means of a suitable device.Inclination degree 0; 5; 10; 15 was,experimental studies were conducted on 3 different mineral fertilizers (Figure 1).

The amount of even distribution of fertilizers on different slopes of the combined plough can be calculated by the following formula, [10].

$$G_b = \frac{G_N}{100} D_x \; ; \quad \text{.....} \quad \text{.....} \quad \textbf{(1)}$$

Here:

G_b – amount of equal distribution of mineral fertilizers in one hectare area, kg

G_N – mineral fertilizer application rate per 1 ha, kg

D_x – is the percentage of equal distribution of mineral fertilizers at different slopes,%

The amount of equal distribution of mineral fertilizers in 1 m^2 of the combined quota can be calculated by the following formula.

$$G_v = \frac{G_n}{100} D_x \; ; \quad \text{.....} \quad \text{.....} \quad \textbf{(2)}$$

Here: G_v – equal distribution amount of mineral fertilizers in 1 m^2 area, gr

G_n – mineral fertilizer fall rate per 1 m^2 area, gr

D_x – is the percentage of equal distribution of mineral fertilizers at different slopes, %

The amount of mineral fertilizers evenly distributed under the plow of the combined plough can be calculated by the following formula.

$$G_p = \frac{G_v}{N} \; ; \quad \text{.....} \quad \text{.....} \quad \textbf{(3)}$$

Here: G_p – amount of mineral fertilizer per plant, gr

G_v – equal distribution amount of mineral fertilizers in 1 m^2 area, gr

N – we have accepted the number of plants in 1 m^2, number N=220.

Figure 2. Experimental study of the combined plough

RESULTS AND DISCUSSION

According to the conducted research, the speed of the combined plough is 4...6 km/h, the width of the fertilizing tool is 1.51 m, the depth of soil cultivation is 18-22 cm, the amount of fertilizer is changed according to the slope of the fertilizer sowing rate, equal distribution in the soil layer (figure 2) [1, 2].The amount of equal distribution of urea, double superphosphate and potassium chloride fertilizers is studied in table 1, table 2, table 3.

The fertilizer of the combined plough was based on the rate of sowing and according to the density of the grain in the field as a result of our experiment.It was studied in table 4, table 5, table 6, taking into account the equal distribution of mineral fertilizers, with an average of 220 plants per 1 m^2 of soil.

The mentioned results allow us to create accurate algorithmic programs for the application of various mineral fertilizers on the slopes, to perform the exact application of fertilizer norms.If we take into account that there are difficult working conditions on the slopes, technological operations and the fact of water and wind erosion of the slopes, it is positive for the assessment of the work of the combined plough.

The combined plough mineral fertilizers, with their uniform distribution, carry out plowing and fertilizing in a single step in various difficult conditions related to the enrichment of soil nutrients.

Table 1. Determination of the quantity of urea fertilizer in the field

No	The amount of fertilizer applied to 1 ha, kg	Even distribution amount of fertilizer given to 1 ha area, kg				Even distribution amount of fertilizer on 1 m^2 of soil, gr			
		Slopes				Slopes			
		0^0	5^0	10^0	15^0	0^0	5^0	10^0	15^0
1.	65	62,4	61,5	59,9	57,7	6,2	6,1	5,9	5,7
2.	76,8	73,7	72,6	70,7	68,2	7,3	7,2	7,0	6,8
3.	88	84,5	83,2	81,1	78,1	8,4	8,3	8,1	7,8
4.	99	95,1	93,7	91,2	87,9	9,5	9,3	9,1	8,7
5.	109,6	105,3	103,7	101,0	97,3	10,5	10,3	10,1	9,7
6.	120	115,2	113,5	110,6	106,5	11,5	11,3	11,0	10,6
7.	132	126,8	124,9	121,6	117,2	12,6	12,4	12,1	11,7
8.	142,3	136,7	134,6	131,1	126,3	13,6	13,4	13,0	12,6
9.	154,2	148,1	145,9	142,1	136,9	14,7	14,5	14,1	13,6
10.	164,4	157,9	155,6	151,5	146,0	15,7	15,5	15,1	14,5
11.	176,2	169,2	166,7	162,4	156,4	16,9	16,6	16,2	15,6
12.	182,7	175,5	172,9	168,3	162,2	17,5	17,3	16,8	16,2
13.	202,7	194,7	191,8	186,8	180,0	19,5	19,2	18,7	18,0
14.	231,8	222,7	219,3	213,6	205,8	22,2	21,9	21,3	20,6
15.	290	278,6	274,4	267,2	257,5	27,8	27,4	26,7	25,7

Contin.Table 1.

16.	348	334,3	329,3	320,7	309,0	33,4	32,9	32,0	30,9
17.	406,6	390,6	384,8	374,7	361,1	39,1	38,5	37,5	36,1
18.	465,4	447,1	440,5	428,9	413,3	44,6	44,0	42,8	41,2
19.	520	499,6	492,1	479,2	461,8	49,9	49,2	47,9	46,1

Table 2. Determination of the quantity of doublesuperphosphate fertilizer in the field

No	The amount of fertilizer applied to 1 ha, kg	Even distribution amount of fertilizer given to 1 ha area,kg				Even distribution amount of fertilizer on 1 m^2 of soil,gr			
		Slopes				Slopes			
		0^0	5^0	10^0	15^0	0^0	5^0	10^0	15^0
1.	103,8	101,3	100,5	97,9	96,3	10,2	10,1	9,8	9,7
2.	122,7	119,7	118,8	115,8	113,9	11,9	11,9	11,6	11,5
3.	140,5	137,2	136,1	132,5	130,4	13,7	13,6	13,3	13,2
4.	158,1	154,4	153,1	149,2	146,7	15,4	15,3	14,9	14,8
5.	175,1	170,9	169,5	165,1	162,4	17,1	16,9	16,5	16,4
6.	191,6	187,1	185,6	180,8	177,8	18,7	18,6	18,1	18,1
7.	210,8	205,8	204,2	198,9	195,7	20,6	20,4	19,9	19,8
8.	227,3	221,9	220,1	214,4	210,9	22,2	22,1	21,4	21,3
9.	246,2	240,4	238,4	232,3	228,5	24,1	23,9	23,2	23,2
10.	262,5	256,3	254,2	247,6	243,6	25,6	25,4	24,7	24,6
11.	281,4	274,7	272,5	265,5	261,2	27,5	27,3	26,5	26,4
12.	291,8	284,9	282,6	275,3	270,8	28,5	28,3	27,5	27,4
13.	323,7	316	313,5	305,4	300,5	31,6	31,4	30,5	30,4
14.	370,2	361,4	358,5	349,3	343,6	6,1	35,9	34,9	34,8
15.	463,1	452,1	448,5	436,9	429,8	45,2	44,9	43,7	43,5
16.	555,7	542,5	538,2	524,2	515,8	54,3	53,8	52,4	52,2
17.	649,3	633,9	628,8	612,5	602,7	63,4	62,9	61,3	61,1
18.	743,2	725,6	719,8	701,1	689,8	72,6	71,9	70,1	69,8
19.	830,4	810,7	804,2	783,4	770,8	81,1	80,4	78,1	77,1

Table 3. Determination of the quantity of potassiumchloride fertilizer in the field

No	The amount of fertilizer applied to 1 ha, kg	Even distribution amount of fertilizer given to 1 ha area,kg				Even distribution amount of fertilizer on 1 m^2 of soil,gr			
		Slopes				Slopes			
		0^0	5^0	10^0	15^0	0^0	5^0	10^0	15^0
1.	92,3	89,4	89,1	87,4	86,5	8,9	8,9	8,7	8,6
2.	109,05	105,7	105,3	103,2	102,2	10,5	10,4	10,3	10,2
3.	124,96	121,1	120,7	118,3	117,1	12,1	12,0	11,8	11,7
4.	140,58	136,2	135,8	133,1	131,7	13,6	13,5	13,3	13,1
5.	155,63	150,8	150,3	147,4	145,8	15,1	15,0	14,7	14,6
6.	170,4	165,2	164,6	161,4	159,6	16,5	16,4	16,1	15,9
7.	187,44	181,7	181,1	177,5	175,6	18,2	18,1	17,7	17,5
8.	202,06	195,8	195,2	191,3	189,3	19,5	19,5	19,1	18,9
9.	218,68	212,1	211,2	207,1	204,9	21,2	21,1	20,7	20,4
10.	233,45	226,3	225,5	221,1	218,7	22,6	22,5	22,1	21,8
11.	250,2	242,5	241,7	236,9	234,4	24,2	24,1	23,6	23,4
12.	259,43	251,5	250,6	245,7	243,1	25,1	25,0	24,5	24,3
13.	287,83	279,1	278,1	272,6	269,7	27,9	27,8	27,2	26,9
14.	329,16	319,1	318,1	311,7	308,4	31,9	31,8	31,1	30,8
15.	411,8	399,2	397,8	390,1	85,9	39,9	39,7	39,0	38,5
16.	494,16	479,1	477,4	468,1	463,1	47,9	47,7	46,8	46,3
17.	577,37	559,7	557,8	546,8	541,1	55,9	55,7	54,6	54,1
18.	660,87	640,7	638,5	625,9	619,3	64,1	63,8	62,6	61,9
19.	738,4	715,8	713,4	699,4	692,1	71,5	71,3	69,9	69,2

Table 4. Determination of the amount of urea fertilizer per plant in the field

No	The amount of fertilizer given to 1 m^2 area, gr	Number of plants per 1 m^2 area, PS	Amount of fertilizer per plant, gr			
			Slopes			
			0^0	5^0	10^0	15^0
1.	6,5	220	0,028	0,027	0,026	0,025
2.	7,7	220	0,033	0,032	0,031	0,030
3.	8,8	220	0,038	0,037	0,036	0,035
4.	9,9	220	0,043	0,042	0,041	0,039
5.	10,96	220	0,047	0,046	0,045	0,044
6.	12	220	0,052	0,051	0,05	0,048
7.	13,2	220	0,057	0,056	0,055	0,053

Contin. Table 4.

8.	14,2	220	0,061	0,060	0,059	0,057
9.	15,4	220	0,066	0,065	0,064	0,061
10.	16,4	220	0,071	0,070	0,068	0,065
11.	17,6	220	0,076	0,075	0,073	0,070
12.	18,3	220	0,079	0,078	0,076	0,073
13.	20,3	220	0,088	0,087	0,085	0,081
14.	23,2	220	0,100	0,099	0,096	0,093
15.	29	220	0,126	0,124	0,121	0,116
16.	34,8	220	0,151	0,149	0,145	0,140
17.	40,7	220	0,177	0,175	0,170	0,164
18.	46,5	220	0,202	0,2	0,194	0,187
19.	52	220	0,226	0,223	0,217	0,209

Table 5. Determination of the amount of doublesuperphosphate fertilizer per plant in the field

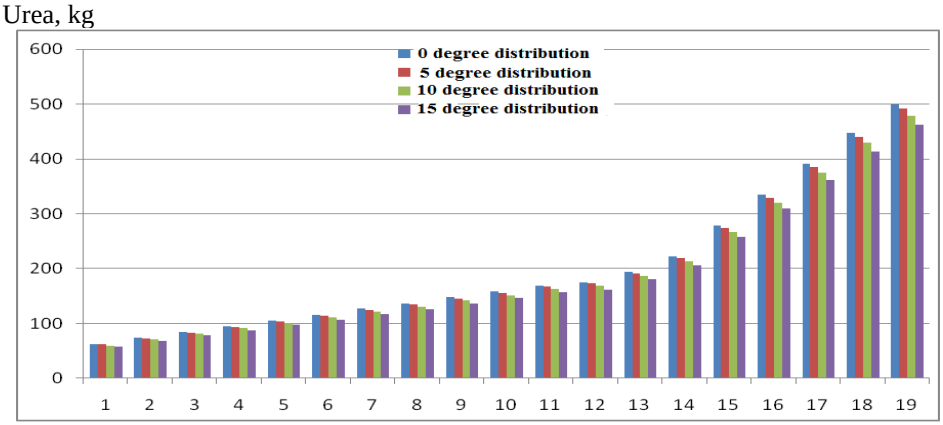
No	The amount of fertilizer given to 1 m^2 area, gr	Number of plants per 1 m^2 area,PS	Amount of fertilizer per plant, gr			
			Slopes			
			0^0	5^0	10^0	15^0
1.	10,40	220	0,046	0,045	0,044	0,044
2.	12,26	220	0,054	0,054	0,052	0,052
3.	14,05	220	0,062	0,061	0,060	0,06
4.	15,81	220	0,07	0,069	0,067	0,067
5.	17,5	220	0,077	0,076	0,075	0,074
6.	19,2	220	0,085	0,084	0,082	0,082
7.	21,08	220	0,093	0,092	0,090	0,09
8.	22,73	220	0,100	0,100	0,097	0,096
9.	24,63	220	0,109	0,108	0,105	0,105
10.	26,25	220	0,116	0,115	0,112	0,111
11.	28,14	220	0,125	0,124	0,120	0,12
12.	29,18	220	0,129	0,128	0,125	0,124
13.	32,37	220	0,143	0,142	0,138	0,138
14.	37,02	220	0,164	0,163	0,158	0,158
15.	46,31	220	0,205	0,204	0,198	0,197
16.	55,58	220	0,246	0,244	0,238	0,237
17.	64,93	220	0,288	0,285	0,278	0,277
18.	74,32	220	0,33	0,326	0,318	0,317
19.	83,04	220	0,368	0,365	0,355	0,350

Table 6. Determination of the amount of potassiumchloride fertilizer per plant in the field

No	The amount of fertilizer given to 1 m^2 area, gr	Number of plants per 1 m^2 area, PS	Amount of fertilizer per plant, gr			
			Slopes			
			0^0	5^0	10^0	15^0
1.	9,23	220	0,041	0,040	0,039	0,039
2.	10,9	220	0,047	0,047	0,046	0,046
3.	12,5	220	0,055	0,054	0,053	0,053
4.	14,06	220	0,061	0,061	0,060	0,059
5.	15,6	220	0,068	0,068	0,066	0,066
6.	17,04	220	0,075	0,074	0,073	0,072
7.	18,74	220	0,082	0,082	0,080	0,079
8.	20,20	220	0,088	0,088	0,086	0,085
9.	21,87	220	0,096	0,095	0,094	0,092
10.	23,34	220	0,102	0,102	0,100	0,099
11.	25,02	220	0,11	0,109	0,107	0,106
12.	25,94	220	0,114	0,113	0,111	0,110
13.	28,78	220	0,126	0,126	0,123	0,122
14.	32,92	220	0,145	0,144	0,141	0,14
15.	41,18	220	0,181	0,180	0,177	0,175
16.	49,42	220	0,217	0,216	0,212	0,210
17.	57,74	220	0,254	0,253	0,248	0,245
18.	66,09	220	0,291	0,29	0,284	0,281
19.	73,84	220	0,325	0,324	0,317	0,314

Uniform distribution of urea fertilizer on 1 ha

Urea, kg



Fertilizer rates

Figure 3. Uniform distribution of urea fertilizer in 1 ha of combined plough

Even distribution of double superphosphate fertilizer on 1 ha

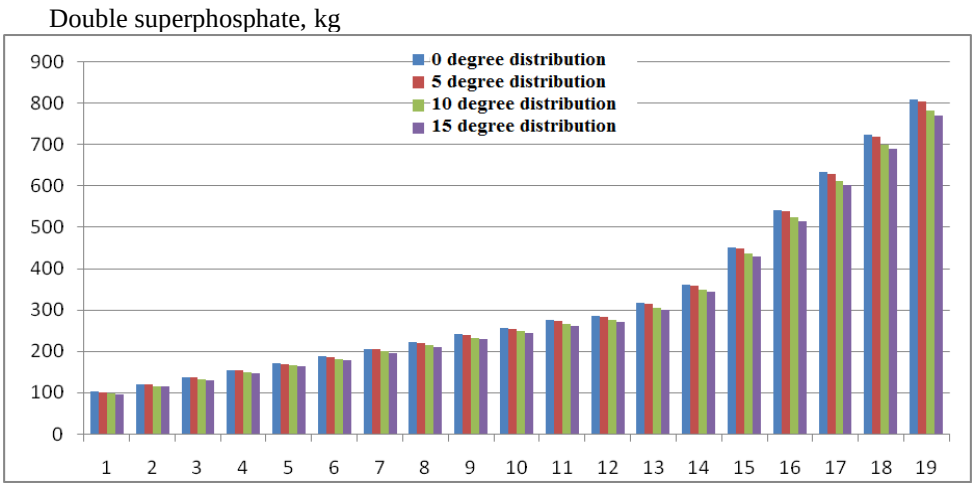


Figure 4. Uniform distribution of double superphosphate fertilizer on 1 ha of the combined plough

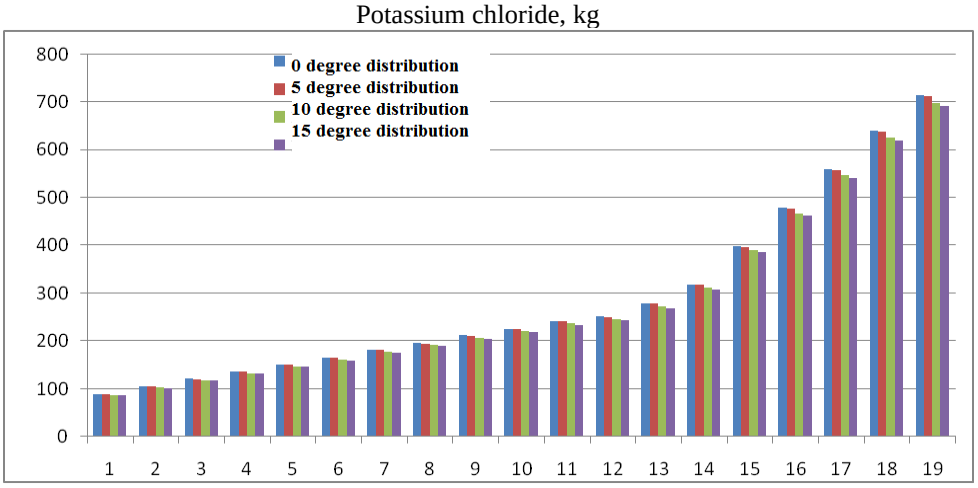


Figure 5. Uniform distribution of potassium chloride fertilizer in 1 ha of the combined plough

From the diagrams shown above (Figure 3, Figure 4, Figure 5) it is clear that the amount of mineral fertilizer scattering increases depending on the slope, and the amount of uneven distribution increases.That is, one of the main factors affecting the distribution is the fertilizer rate.Fertilizer rate is regulated on 19 levels. The combined fertilizer is successful in applying mineral fertilizers in the required rate.

It is known from the diagrams that the density and granularity of mineral fertilizers affect the even distribution. With the equal distribution of mineral fertilizers per hectare, the feeding area of 1 plant is 45 cm^2.These indicators characterize the normal food area.

The newly created combined plough has made it possible to obtain 6 centners more than the productivity of grain crops by distributing mineral fertilizers evenly under the soil under special difficult conditions.At the same time, quality grain was obtained.

As a result of combined plough laboratory and field tests in grain growing, 5.7...49.9 g of urea, 9.7...80.4 g of double superphosphate, 8.6...71.5 g of potassium chloride mineral fertilizers, per 1 m^2 area performs equal distribution on slopes forming angles of 0...15 degrees. Equal distribution of mineral fertilizers was on average 92% in urea, 94% in double superphosphate, and 93% in potassium chloride.

CONSLUSION

1. The use of the combined plough completely reduces the operation of spreading fertilizer with fertilizer spreading machines before the plowing operation, the costs and labor spent on it, and it ensures that the operations are performed in a short time by saving time. Distribute fertilizer under the ground is environmentally friendly and prevents fertilizer loss.

2. As a result of the farm test of the combined plough, the working speed was 4-6 km/h, the working width was 1.51 m, the cultivation depth was 20-25 cm, and the fertilizer sowing rate was 65-830 kg/ha.

3. The average indicator of the experimental combined plough for spreading solid mineral fertilizers with the given construction and kinematic parameters was the equal application of granulated urea fertilizer - 92%, double superphosphate 94%, potassium chloride - 93%, the working width of the unit was 1.51 m.

4. Combined plough 5.7-49.9 g of urea, 9.7-80.4g of double superphosphate, 8.6-71.5 g of potassium chloride mineral fertilizers, evenly distributed on 1 m^2 area, 0-15 on slopes forming angles of degrees.

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REZULTATI ISTRAŽIVANJA KOMBINOVANE MAŠINE ZA ĐUBRENJE ZEMLJIŠTA NA NAGIBU

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Apstrakt: Jedna od važnih agrotehničkih mera koja obezbeđuje predpostavku visokog kvalitetnog prinosa, je ravnomerna raspodela mineralnih đubriva u polju. Distribucija hranljivih materija (azot, fosfor, kalijum) u jednakim količinama, obezbeđena je po dubini u sloju zemljišta. Na ovaj način, stvara se okruženje stalne i pravovremene ishrane semena. Ravnomerna raspodela mineralnih đubriva u zemljišnom sloju u gajenju žitarica, kao i otpornost biljaka tokom zimskog perioda, kasnije, pozitivno utiču na visinu biljaka i kvalitetno zrenje zrna kulture koja se gaji.
U našem istraživačkom radu, ravnomernom raspodelom mineralnih đubriva u zemljišnom sloju, dobijeno je više od 6 centi kod prinosa po hektaru.
U našoj laboratoriji razvijena je kombinovana mašina, obavljeni su ogledi na polju i laboratorijska ispitivanja.
Prema glavnim rezultatima istraživanja uzete su 3 vrste mineralnih đubriva. Urea, dvostruki superfosfat, kalijumova đubriva su određena u procentu raspodele i količini đubriva na nagibima do 15 stepeni. U zavisnosti od nagiba određivana je količina raspodele mineralnih đubriva po 1 m^2 i količina đubriva po pojedinačnoj biljci.
Na osnovu dobijenih rezultata istraživanja, urađeni su i analizirani grafikoni i tabele.

Ključne reči: *Kombinovani plug, nagib, mineralna đubriva, jednaka raspodela, stepen*

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